Assessment of the environmental and health impacts arising from mercury-free dental restorative materials

Hannah Binner[1,2], Naghmeh Kamali[1,2], Mairead Harding[2], Timothy Sullivan[1]

1) *Department of Biological, Earth and Environmental Science, University College Cork;*
2) *Oral Health Services Research Centre, Cork University Dental School and Hospital.*

Rationale of research

LESS Hg – Looking to Environmental Sustainability and Securing Health goals

The European Union introduced Regulation 2017/852 to implement the Minamata Convention on Mercury. Article 10 of the Regulation is pertinent to Dentistry and the use of the fillings traditionally referred to as 'silver fillings', which are an amalgam of mercury, silver, tin and copper. To reduce the amount of mercury in use and manage waste more sustainably in Dentistry, dental amalgam separation units can be installed within the dental treatment unit and alternatives to the traditional silver fillings exist. These mercury-free alternatives are often referred to as 'white fillings', many of which are constituted of resin polymers and glass or silica particles. The use of these 'white fillings' has steadily increased since the 1990s, although research is sparse on their environmental and health impacts.

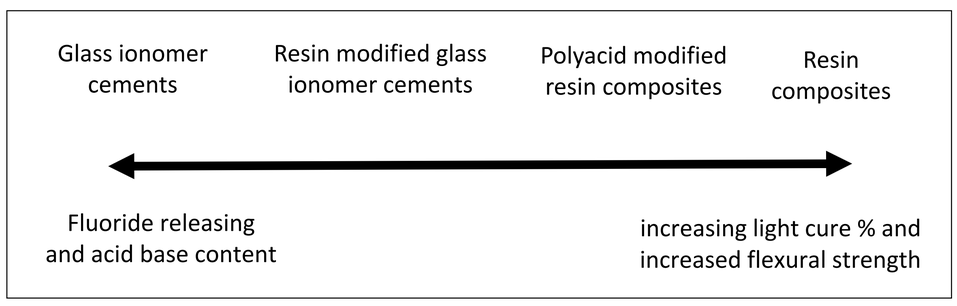
Expected outcomes of this study include (i) a methodology for identification and quantification of mercury-free dental filling material particles/substances entering wastewater from dental practices, (ii) an assessment of the efficacy of amalgam separation units in capturing these materials, and (iii) identification of potential occupational exposure routes and risks including recommendations to minimise exposure within dental practices.

This study has the potential to add to the body of knowledge, make recommendations, to inform policy and investigate the use of mercury-free dental materials on health and the environment.

Materials

Commonly used mercury-free dental restorative materials, often referred to as 'white fillings', include:

- Glass ionomer cements (GIC)
  - Glass and polyacrylic acid
- Resin-modified glass ionomer cements (RMGIC)
  - Conventional glass ionomer cement containing glass, polyacid, tartaric acid and water
- Polyacid modified resin composites
- Resin composites (RC)
  - Principle monomer (Bis-GMA, Bis- EMA) and filler (glass/cement)



The mercury-free dental restorative materials include a range of materials, chemicals and particle sizes (20 nm to 100 µm), which require testing with a range of different testing methods.

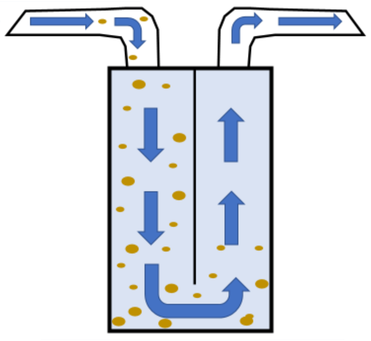
Waste collection systems

The dental wastewater lines from the dental chair suction and sink undergo at least two stages of filtration, followed by amalgam separation before the wastewater is discharged into the sewer.

Given the composition of dental materials, their state in the wastewater may either be inert, polymerised, part-polymerised, solid, paste or liquid.

While the filtration may filter out any larger particles, their main purpose is to prevent the clogging of pipes. Therefore, the centrifugal force operating in the amalgam separator aiding the separation of solids and liquids offers a more effective method of waste collection. The amalgam separators are ISO certified and must be at least 95% effective in removing amalgam as per obligation set out in the Dental Council's Code of Practice regarding Infection Prevention and Control. Hence, operating on the basic principles of centrifugal force, there is a possibility that other dental materials become trapped.

Sample collection from dental wastewater



Procedures for analyses

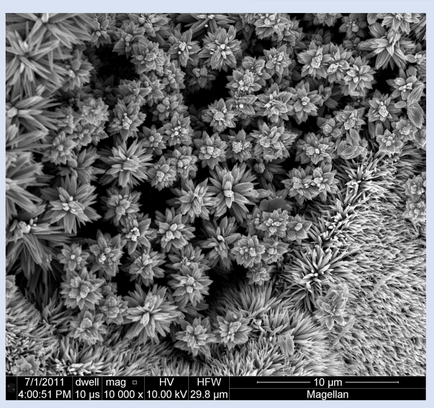
Firstly, a range of analytical chemistry methods will be determined in order to capture materials of different size and shape using a combination of microscopy methods, such as Scanning Electron Microscopy and Raman spectroscopy. **Aim:** particle size distribution, shape and chemical compositon.

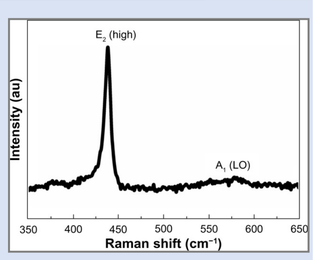
Secondly, concentrations of mercury-free dental materials in wastewater streams will be determined using a combination of UV-Vis spectroscopy, Dynamic Light Scattering and FT-IR. **Aim:** quantification.

Initial toxicity and potential hazards arising from the presence of micro- and nanoparticles from mercury-free dental restorative materials in wastewater streams will be examined using a range of ecotoxicological screening tests such as bacterial samples, algal samples, duckweed or *Daphnia magna* (e.g. 48 h static acute test). **Aim:** toxicity testing and potential hazards.

Expected outcomes: a greater scientific understanding, quantification and potential impacts of substances/particles from mercury-free dental filling materials entering the environment via wastewater from dental practices.

& Data Analyses





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